CHAPTER 3.—RESEARCH DESIGN AND SAMPLE PROFILE

Homans [1950] offered a working definition of group that is useful for this research: "We mean by a group a number of persons who communicate with one another often over a span of time, and who are few enough so that each person is able to communicate with all the others, not at secondhand, through other people, but face-to-face." This chapter begins with a discussion of the group concept in reference to the hypothesized escape groups mentioned earlier. It then moves to an examination of analysis techniques used by the authors. Finally, the subjects themselves are profiled according to their demographic characteristics.

The Nature of Groups

Warriner [1956] took a realist approach to understanding groups: "(1) the group is just as real as the person, but (2) both are abstract, analytical units, not concrete entities, and (3) the group is understandable and explicable solely in terms of distinctly social processes and factors, not by reference to individual psychology." Warriner's realist position merely holds that "group" occupies a different domain in which it is no more or less concrete than "person." At this group level the unit of analysis will be those relations that indicate social rather than individual behavior. It is possible to investigate these group properties empirically—if a researcher avoids confusing conceptual entities with concrete ones. Most people seem to accept that group attributes must somehow be inferred, but think personal attributes will be directly manifested, requiring little or no interpretation [Snizek 1979]. In other words, nobody would equate physical components of an underground working section with the actual work group, yet social scientists (as well as laypeople) very often confuse real individuals with notions of the person. In actuality, neither groups nor persons are directly disclosed to the senses; both are inferred by experience and observation. One can "see" a group just as clearly as one can "see" a person, given the proper perspective from which to do so. It is necessary, in developing this perspective, to begin with a sound definition of the thing being examined.

Besides communication, or more generally, social interaction, Homans [1950] included three other components of group makeup. "Sentiment" is characterized as the feelings people tend to form about one another when they interact often. These feelings include not only friendliness and dislike, but attitudes such as approval or disapproval. A "norm" is an idea, held in common by group members, that specifies how people *ought* to behave in given circumstances. In lay terms, norms are simply those informal rules individuals abide by in order to get along together in social situations. Finally, "activity" refers to those things persons do with others. In work groups, as an example, many of the activities are cooperative and goal-directed.

Most underground mining activities are carried out as team work. Workers at the face interact routinely to coordinate various tasks in the extraction cycle. Crews that work outby also communicate and assist each other in order to do their jobs. These reciprocal relations exist in a daily context of danger. A mistake on one worker's part could injure or kill others. The need to deal with this danger and predict what one's coworkers are likely to do in a given situation has resulted in a complex of sentiments and rules governing individual behavior. Simply stated, miners pressure each other to behave in terms of collective expectations and use a range of sanctions to ensure conformity [Smith and Vaught 1988]. A result is what Lee [1970] termed the "illusion of universality." This is a general feeling that group members have the same outlook and tend to define things similarly [Shibutani 1955]. Thus, a miner's attraction to his or her "buddies" is seen as right and proper, where "one's very self, for many purposes at least, is the common life and purpose of the group...the simplest way of describing this wholeness is by saying that it...involves the sort of sympathy and mutual identification for which 'we' is the natural expression" [Cooley 1909].

For underground miners, the sentiment that "we must stick together" may be a "sacred code" [Lucas 1969] so strong it has a bearing upon how individuals behave toward each other during a fire. Johnston and Johnson [1988] noted that an emergency does not necessarily signal the breakdown of social organization. Rather, functional roles that already exist are merely adapted and extended into the crisis. In a mine, where workers feel that survival under ordinary circumstances may well depend on "having a good buddy who watches out for you" [Wardell et al. 1985], it is almost certain they will be trying to help each other escape. How and under what circumstances this helping behavior occurs is a concern of the research team. Since the literature reviewed in chapter 1 suggests that group escape attempts may actually increase an individual's survival chances, what then makes an effective escape group? At what point does a situation dictate that "it's every man for himself," as one respondent reported, and how might this sentiment be avoided? To answer these and other questions about escape behavior, it is necessary to explore the nature of those groups that evacuated the three fires reported in this study.

Research Strategy and Method

A general case study strategy has been used in this research and the design should not be confused with any particular method of data collection and analysis. Nevertheless, such misunderstanding occurs frequently and tends to cloud discussion [Platt 1988]. This issue can be clarified succinctly. Case studies are nothing other than a way to "explain wholistically the dynamics of a certain historical period of a particular social unit" [Stoecker 1991]. In other words, they set the boundaries of a research effort rather than determine how it

will be carried out. For the present study, each of the eight escaping groups is treated as a separate case having unique aspects as well as certain commonalities. The time periods are well-defined, beginning with a warning and ending when group members reached safety. Likewise, each social unit is clearly identifiable: those miners who came out of their operation together. The research task is to explain the dynamics of these different groups.

Analysis of each subject of interest was first done within the escape group. "A single case can undoubtedly demonstrate that its features are possible and, hence may also exist in other cases and, even if they do not, must be taken into account in the formulation of general propositions" [Platt 1988]. A multiple-case design was used so that variations across cases could also be examined. "In a multiple-case study, one goal is to build a general explanation that fits each of the individual cases, even though the cases will vary in their details." [Yin 1984]. Multiple cases are not used as a sample of the population, but as replication of an analysis. Each case "(a) predicts similar results (a literal replication) or (b) produces contrary results but for predictable reasons (a theoretical replication)" [Yin 1984]. In this study, the resulting explanations were based on what was learned about each group, as an individual case, and about subjects of interest as they were exhibited (or not exhibited) across the eight groups.

Information for the present study has been taken from various sources. Existing literature was used to provide a theoretical notion of how escape groups might be expected to function. Mine Safety and Health Administration investigative reports helped researchers build pictures of each fire situation. These narratives also provided insights about the efficiency of given escape efforts. The main data source, however, is a set of open-ended responses collected during interviews with workers who escaped through smoke in the three mines. Forty-eight miners, supervisors, and State or Federal inspectors gave accounts of their experiences. "An account is the personal record of an event by the individual experiencing it, told from his point of view " [Brown and Sime 1981]. Thus, the focus of analysis are these qualitative data. Further, while some responses in the database refer to individuals, only data that lead to a better understanding of the group will be considered here. Each escape group will be portrayed through the accounts of its members.

Quantitative methodologists often profess difficulty understanding how a qualitative strategy and its related activities can be made legitimate. The use of open-ended data, such as personal accounts, is frequently criticized by those who are more familiar with experimental or quasi-experimental quantitative methods. These scientists usually raise issues of reliability and validity when questioning the soundness of qualitative research. In general, reliability denotes the tendency of a measuring procedure to behave in a constant manner each time it is applied. The concept of validity is not quite so intuitive. Essentially, however, a valid procedure is one that measures what it is supposed to measure. From a

traditional (or empirical) frame of reference, the type of information-gathering that depends on subjective responses has some major flaws.

First, independent and dependent variables may not be well specified and probably could not be measured accurately even if they were [Stoecker 1991]. Since reliability depends on the degree to which a finding "is independent of accidental circumstances" [Kirk and Miller 1990], it is vital that any variable of interest can be linked with an empirical indicator. It will then be possible, through repeated trials, to determine the constancy of this indicator as a measurement tool. Consistent measurement is necessary if researchers are to separate legitimate findings from accidental factors that introduce error [Carmines and Zeller 1987]. Without this type of rigor, empiricists argue, potential bias would be obscured and hence undetected. Thus, there could be no guarantee of internal validity. Internal validity allows the researcher to conclude that it was a specified independent variable, rather than some third factor, which caused change in a dependent variable [Yin 1984]. Because it is very difficult to establish the reliability and internal validity of open-ended responses in a traditional sense, such data get labeled as "impressionistic" and unusable for causal analysis.

A second shortcoming of qualitative research, according to quantitative methodologists, is that data obtained under uncontrolled conditions do not allow the use of probability statistics and therefore are not generalizable. This question of representativeness involves the problem of external validity: "To what populations [and] settings...can this effect be generalized?" [Campbell and Stanley 1966]. In situations where a proper sample has been taken, it is possible to control statistically for interactions of factors that may have an impact on the dependent variable. A researcher can then draw conclusions about some measured observation and infer how it will impact infinite similar circumstances. Since the qualitative methodologist neither takes broad and random samples nor calibrates responses, it is deemed there is no way to answer the question of "whether the researcher sees what he or she thinks he or she sees" [Kirk and Miller 1990]. This "nonquantitative" scholar is also viewed as being unable to make any empirical leap from particular events to those universal axioms that are the ultimate goals of science.

Yet qualitative methods, which became virtually ignored in most disciplines following the rise of computer analysis and sophisticated statistical techniques, have had a phenomenal resurgence in the past decade [Miles and Huberman 1994]. Perhaps the chief reason for this renewed interest in, and use of, open-ended data has been the growing recognition that quantitative science leaves gaps in our attempts to answer "how" and "why" questions. Stoecker [1991] listed three basic responses to the proponents of experimental or quasi-experimental research that suggest what some of the foibles are: "First, probability samples and significance tests do not insure accurate explanation.

Second, the scientific method does not control for researcher bias. Third, the survey research preferred by scientific method advocates is not useful for applied questions." No matter how well a study is controlled, a scientist who wishes to go beyond the immediate evidence and make statements about some population or universe must assume he or she "knows the relevant laws" [Campbell and Stanley 1966]. The strength of one's assumptions rests upon knowledge, experience and creativity, i.e., any type of science is only as good as its practitioners.

If there is a place in science for nonquantitative research, what might that place be? Insofar as case studies are concerned, they usually are thought of as exploratory or descriptive in nature. This is especially so for work that relies on qualitative analysis (such as the present research). The appropriateness of a particular strategy, however, should be decided not by its nature but by the purpose for which it is being used. Yin [1984] listed three conditions that need to be considered before choosing a research strategy: (1) the type of research question being posed, (2) an investigator's extent of control over actual events, and (3) whether the events being focused on are current or historical. Questions that consider how or why certain contemporary events occur, but over which the researcher has no control, are particularly amenable to a case analysis. Furthermore, a qualitative case study, used as an explanatory mechanism, "provides evidence to show how both the rule, and its exceptions, operate" [Stoecker 1991].

The present qualitative research makes no effort to count something or measure a quantity. Instead, team members have attempted to determine the presence or absence of group behavior in a fire setting and then explain its variability in those instances where it is seen to exist. The question relevant to reliability, in this case, is whether group behavior was studied by the researchers in a way that created a false reflection of it. Kirk and Miller [1990] suggested the proper response to that question: "For reliability to be calculated, it is incumbent on the scientific investigator to document his or her procedure." As in reports of quantitative research, the qualitative methodologist must make explicit the way the study was designed and carried out. In so doing, he or she guarantees that other scientists can determine whether or not the methodology is sound. They then have an occasion to replicate the techniques, if appropriate, in other settings.

Validity, in the case of these three fires, involves an assumption that USBM researchers did, in fact, observe or detect what they were attempting to investigate. In qualitative studies, the fundamental tools used are a researcher's powers of observation or an ability to ask appropriate questions at the right time. A qualitative researcher often gains confidence in findings by using a structured instrument to examine an issue or variable of concern. The primary instrument used to gather data during this research was an interview guide (see appendix B).

This guide requested individuals to provide an account of their personal experiences in the fire from which they escaped. Brown and Sime [1981] addressed the appropriateness of such an approach: "Fundamental to the philosophy of an account methodology is the recognition that people can and do comment on their experiences, and that these commentaries are acceptable as scientific data." If a person making an observation is skilled and his or her instruments properly constructed, then any subsequent conclusions ought to be considered valid. In reporting these results, of course, it is important to recount the methods that were used. Their appropriateness and proper use can then be evaluated by other researchers. Each of these scientists will ultimately decide if the instrument was constructed correctly and if the researchers were skilled in its use.

In each case, after hearing about an event, researchers involved in this study contacted officials from both the affected company and the United Mine Workers of America (the labor union that represented rank-and-file employees at all three sites). Investigators requested management and labor's cooperation with an ongoing study of miners' responses to underground mine fires. At mines A and B, union officials agreed to set up interviews with miners who had escaped their fires. One union and one management official set up the interviews that were conducted with those individuals who escaped the fire in mine C. Worker accounts were gathered at locations convenient for the participating miners. Interviews of mine A workers were conducted in a room at the local union hall. Individuals who escaped mine B were interviewed at a motel close to the mine where they worked. The interviews at mine C were conducted in offices on mine property.

Nobody except one subject and two research scientists was permitted in the room during an interview. The miner was first asked for permission to tape record his account. All subjects agreed to be taped. A written schedule (mentioned previously and shown in appendix B) with a series of open-ended questions and related probes was used to guide every account. Each interview began with an investigator reiterating that participation in the study was voluntary and that the miner had an option of not answering any particular question.

After obtaining general demographic information, an interviewer next asked the miner to tell, without interruption, his story about escaping the fire. Followup questions were then used so that specific details about each escape could be included. The sessions, which were 30 to 90 minutes long, ended when a researcher had asked all questions on the interview guide and a miner did not have any additional comments. These interviews were completed 1 to 6 months after each fire had occurred.

The audiotapes were transcribed and stored on computer disks as text-based data. This data set has been analyzed with the assistance of a program that acts,

in effect, as an electronic substitute for scissors and paste [Seidel et al. 1988]. The computer application allows files to be sorted by category and cross-referenced according to some predetermined coding scheme. This feature enables the easy retrieval and juxtaposition of specific categories during analysis. Analysis can then begin with a series of coding passes. The first pass might simply identify instances of situations in which a group property either exists or explicitly does not exist. The next level of coding could include concepts such as composition, stability, or interactions. The coding scheme can be further defined during this process and coding continued as needed. Findings may then be used to create a group behavior model.

After the accounts were gathered, a comparative method of qualitative analysis was employed [Glaser and Strauss 1967]. In the comparative approach, a researcher develops as many categories as will clarify the problem. Next, he or she starts integrating categories and the properties that make them up, beginning to connect concepts with their indicators [Claster and Schwartz 1972]. After integrating categories and properties, the researcher is then ready to move toward simplicity and a broader scope [Glaser and Strauss 1967]. Over time, a theory of the event under investigation will emerge and be modified as more data are added. As the theory is streamlined, researchers are able to arrive at an assessment of how typical those occurrences that went into its construction are likely to be [Becker 1970]. The logic underlying this assessment is the same as that which supports probability: instead of adopting an either/or stance about the accuracy of particular assertions, one addresses the likelihood that his or her conclusions are correct. The magnitude of evidence from various data sources enables an observer to advance a particular conclusion with a greater or lesser degree of confidence.

Profile of the Sample

Across the 3 mines and 48 subjects, 8 separate groups of workers escaped through smoke. Table 3.1 shows the number of miners in each escape group and the number who were actually interviewed. The sample includes workers from various job categories. Forty-two of these individuals were rank-and-file miners who worked throughout the mines. One mine inspector and five supervisors were interviewed. These workers were 41.7 years old on average. They had a mean of 16.8 years of experience in mining with about 15 years at the operation where they were working at the time of their fire. The average age and number of years of experience for each group are shown in table 3.2. All of the miners included in this sample were male. One female did escape with a group from Adelaide, but she chose not to participate in the study. To further define the context within which these people were required to act, each escape group and its situation will be discussed briefly below.

Table 3.1.—Number of miners in each escape group and number in sample

Group	Mine	Population N (total ' 65)	Sample N (total ' 48)
1	A	10	8
2	A	8	6
3	A	10	7
NAp	A	NAp	1
4	B	8	7
5	B	9	7
6	B	3	1
NAp	B	NAp	1
7	C	8	5
8	C	9	5

NAp Not applicable.

Table 3.2.—Average ages and years of experience of miners in escape groups

Group	Mine	Average age (N ' 42)	Average years (total ' 16.8)	Average years at this mine (total ' 15.2)
1	A	41.8	17.1	17.1
2	A	39.3	14.3	14.0
3	A	39.7	17.6	15.0
4	B	41.7	17.2	16.7
5	B	40.3	17.6	14.4
6	B	56	25	15
7	C	38.8	13.9	13.9
8	C	40.0	14.7	13.9
Total	—	41.8	16.8	15.2

Escape Profiles

Group 1 (1 Right - Adelaide) was a production crew. This group had a new section foreman who was working his first shift in the mine after a 5-year absence. He was not familiar with the affected area; As one worker put it: "The boss, I can't blame the boss. This was the first time he was on the section in 5 years." Additionally, the crew had recently been "split up," and some regular workers had been replaced with experienced miners from other sections. As a result, at least three group members besides the foreman were unfamiliar with this part of the mine. Group 1 started the evacuation riding their mantrip. This mode of travel continued until the crew encountered heavy smoke. At that point the driver stopped the vehicle and everyone got out: "We had two or three running—everybody was panicked." After some initial confusion, the group members gathered and started walking together out their intake escapeway. They soon hit smoke in this entry as well. Group 1 moved into a return airway and continued walking. Shortly thereafter, the group members encountered smoke again. At this point, they donned their self-contained self-rescuers and walked through smoke to safety.

Group 2 (2 Northwest - Adelaide) was also a production crew. These

workers had all been together for a significant amount of time. They had a section foreman who was very familiar with the affected area. One other resource in this group was an individual who had been a mine rescue team member for many years. "We had the boss and the mine rescue man set it up, the boss in front, he was in the rear." Group 2 started to leave the mine on a mantrip. The group members had only gone a short distance when they encountered smoke. They did not leave the mantrip at this point, however. Instead, they rode back up into the section to where they had started. They then got off the vehicle and started walking down their intake escapeway until they encountered smoke. Group 2 next moved into the return to avoid the smoke and continued walking. When smoke was found in the return, this group donned the self-contained self-rescuers and proceeded for about 1 mile to reach safety: "We were about as organized as you're going to get. We did real good." "We all stuck together real well."

As with group 1, miners in group 3 (3 Left - Adelaide) had some new members the night of their fire. Most, however, had worked together for several years. At the beginning, everyone rode together until they encountered smoke. As in the first group, they next started walking down their intake escapeway and hit more smoke. They then moved into a return and walked until they got into smoke, at which point they decided to don their self-contained self-rescuers. The next phase of their escape, however, differs from group 1. They did not escape as a cohesive unit, instead spreading out to form three subgroups. While walking through smoke, this crew became lost and was actually moving deeper into the mine: "We went in a little circle and come back around." They had gone approximately 200 ft when one of the miners recognized their mistake. At that point, everyone turned around and this time successfully found their way out of the mine.

When group 4 (4 South - Brownfield) gathered, smoke was already visible in the intake entry. In addition to the section foreman and regular crew, group 4 contained a Federal mine inspector who had been on the section. This group, unlike the others, did not choose the return as a second option. The group thought that smoke would also be found in that entry: "The boss and the inspector was there, and they were discussing which way to go—which would be the best way to get out. So they decided it would be down the belt. We all went down the belt." However, the belt was not clear. Like group 3, group 4 spread out, with some slower workers lagging behind, accompanied by the inspector. They completed the escape in the belt entry through the smoke.

Group 5 (5 South - Brownfield), a production crew, was led out by its section foreman with help from a rank-and-file miner who knew the affected area well: "[The foreman] is our boss. He...done right. He got us on the right track and kept us on the right track. Between him and [the other guy]." After group 5 assembled, the group members walked down the intake entry until they

encountered smoke. Like group 4, they tried the belt entry next. The smoke there was not as heavy at first. When it became heavy, they moved to the return. The return was also smoke-filled, but they traveled on through the smoke. Some of the workers had difficulty due to age or physical problems and slowed down. The section foreman stayed with these people to make sure that everyone reached safety.

Members of group 6 (6 West - Brownfield) included three individuals. These were a maintenance foreman and a mechanic (who worked together regularly) plus a State mine inspector. All three donned their self-contained self-rescuers as soon as they assembled at the intake escapeway. Even though their haulage was clear initially, this group, influenced by input from the State mine inspector, decided against attempting to travel in a vehicle. They started their escape walking down the intake entry. When they reached heavy smoke, they retreated and moved into a return: "I mean, the inspector, when I turned around and said we got to go back, he says no, and I says, you can do what you want to do, I'm going back." The men made a couple of turns, but basically followed the return out of the smoke to clear air: "The markers (reflectors) were there. I mean, I really wasn't looking for them...the return is double-timbered. I just stayed between the props and went."

Group 7 (7 Butt - Cokedale) was a collection of individuals working in an area on midnights, which was a maintenance shift at their mine. Here, a construction foreman took charge and led them out of the mine: "I was a foreman in charge of that area, and when I said to these people what we had to do, there was no second guessing my decision." As with groups 1, 2, and 3, these miners also started their escape by attempting to leave the section on vehicles. When they judged the smoke to be too heavy for continuing safely, everyone started walking in a return entry: "I felt pretty confident...because I knew [the foreman] had been up there for a long time walking returns and...he was real familiar with the area." In all, they walked through smoke for about 1.5 miles. Throughout their escape, respondents recalled, the construction foreman displayed knowledgeable, decisive, and confident leadership.

None of the individuals in group 8 (8 Face Parallels) were engaged in coal production, because they were also working the maintenance shift at their operation. Most of them were involved in such support work as construction and supply activities. Additionally, two motormen were in the section when fire was discovered. Everyone gathered and began their escape on foot. Like all of the groups except 5 and 6, they started out in their primary intake escapeway: "There was a lot of confusion...the boss couldn't figure out how to get into the intake escapeway." When they encountered smoke there, the men turned around and returned to the section, as group 2 did. They then attempted to travel down a return entry. After walking about 0.25 miles, someone realized that they were not in a designated escapeway: "The guys were more or less talking amongst

themselves and I said, you know, this is real serious and this boss if we're not careful, he's going to get us killed." At this point, everyone returned to the section for a second time. They then found a designated alternate escapeway and followed it through smoke to safety.

Discussion

All eight of the escapes took place under potentially deadly conditions. The miners traveled in smoke for thousands of feet. Individuals had to use self-contained self-rescuers to protect their lungs as they moved through this smoke. Some of the escape routes were objectively more complicated than others, but all were difficult to traverse.

The summaries above give very general overviews of each escape in order to suggest some of that associated complexity and difficulty. This is done to help readers more fully identify with the study's context. In the chapters that follow we will discuss at length details of each group and the area from which it escaped. Subjective analyses of danger and the effects of those perceptions on group behavior will be a large part of that discussion.

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